

## A REPORT OF CURRENT STATUS AND DISTRIBUTION OF POTATO FOLIAR DISEASES IN PUNJAB, PAKISTAN

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In Pakistan, potato production has become an important industry both for farmers and consumers. Potato cultivation in Pakistan is always taken on priority among the other vegetables due to its high yield, having high nutrient values and mostly increasing the income of the farmers. First time we documented the incidence of foliar diseases from the hub of potato growing areas. We selected 5 potato fields from each district of Okara, Pakpattan and Sahiwal to collect passport data of foliar diseases after 30, 60 and 90 days intervals. The incidence of late blight was the maximum in all selected districts followed by black leg and early blight. In district Okara the incidence of late blight was the maximum (30%) while the minimum incidence (7%) was recorded in district Sahiwal. The maximum (6%) incidence of black leg was recorded in district Sahiwal followed by Pakpattan and Okara districts. This study concluded that late blight is serious threat to potato industry in district Sahiwal, Pakpattan and Okara and it can be minimized by good agricultural practices.

**Keywords:** *Solanum tuberosum*, somatic reproduction, microtubers, seed potato, fungal diseases, crop husbandry.

### INTRODUCTION

Potato plays an important role in food security as it is world's most important food crops and ranks 4<sup>th</sup> in production and 5<sup>th</sup> in area (Rauscher *et al.*, 2006). Tuber is the most important part of plant which is high in proteins, carbohydrates and vitamins (Ducreux *et al.*, 2005). Potato has somatic reproduction system as "seed" tubers are used to grow the crop for consumption. In sophisticated potato seed production systems, pathogen free micro-tubers are grown in tissue culture and then transferred to small pots or glass houses. Afterwards, plants are transferred to the field where there is low disease pressure to grow for generations. Fields are also inspected for diseases throughout in order to maintain minimum seed health standards and to make available to farmers for large scale production. Infected tubers can result huge damage to the potato crop (Hane and Hamm, 1999).

Pakistan is counted 19<sup>th</sup> position among the potato producing countries with potato cultivated area 188.6 hectares and production of 4609 tones. Punjab ranks 1<sup>st</sup> in potato production followed by KP (Khyber Pakhtunkhwa), Balochistan and Sindh (Pakistan Economic Survey, 2019-20). Potato is mostly cultivated in central districts of Punjab province including Sahiwal, Okara, Pakpattan, Kasur and

Lahore. Small areas of Peshawar, Dir, Kalat and Kaghan are also under the cultivation of this crop (Malik, 1995). Among the factors limiting potato production in Pakistan are poor crop husbandries by farmers such as no crop rotation, poor disease management, little pest control and poor knowledge about seed treatment. Thus, improvement in the production system of potato is needed due to the increased demand for potatoes and potato products in the country.

Several diseases have been found to affect the potato crop. In Pakistan, eighteen potato diseases are reported in previous literature in different growing regions. Among these diseases early and late blight, wilt, stem rot, soft rot, powdery scab and black leg are frequent in Pakistan and most of these diseases spread through myco-pathogenic spores and are airborne (Ahmad, 1998).

Potato blight (*Phytophthora infestans*) is a major disease of tubers and can cause complete crop damage. Further, black leg (*Erwinia carotovora* var. *atroseptica*), and other viral diseases such as potato leaf roll disease also significantly reduce yield. The incidence of major diseases is related to genetic, environment and management factors (Elcock *et al.*, 1998). Studies on occurrence of these diseases in Pakistan will be beneficial and valuable for the potato growing areas. Data regarding incidence of disease spread on potato crop can



be helpful in developing methods to improve seed quality that ultimately result in good production. Considering the potato diseases in Pakistan, the present study was planned to investigate the incidence and severity of potato diseases in major potato-growing areas of Pakistan. Further, the objective was also to collect agronomic and husbandry data for disease incidence and management practices relationship.

## MATERIALS AND METHODS

**Area surveyed:** A comprehensive survey was designed to investigate major foliar diseases including late blight (causal agent *Phytophthora infestans*), early blight (causal agent *Alternaria solani*) and black leg (causal agent *Erwinia carotova*) in Sahiwal, Okara and Pakpattan which are primary potato-growing districts of Pakistan. In each district, we selected five locations of potato fields and visited after 30, 60 and 90 days intervals for assessment of foliar disease. In Sahiwal, Potato Research Centre Sahiwal, Punjab Seed Corporation Sahiwal, Chak No. 90/9 L, Chak No. 34/9L and Pakpattan road Sahiwal were selected. In Okara, the locations were Chak No. 39/3R, Chak No. 39 D, 5 KM Dipalpur, Kharak Singh and Chak No. 35/2L. In Pakpattan, Chak No.17/SP, 2L Bodla Wala, Malik Pur, Kaboola Road Pakpattan and Chak No. 18/SP were investigated.

**Disease survey and collection of samples:** The study area in each location was 3x3 meter with 3 replications. The data were recorded after 30, 60 and 90 days intervals after crop germination. The disease incidence was calculated by using following formula (Khalid *et al.*, 2000).

$$\text{Disease incidence (\%)} = \frac{\text{No. of infected plants}}{\text{No. of plants examined}} \times 100$$

**Confirmation of disease vector under microscope:** Infected leaves were collected from the fields and analyzed disease vectors under microscope following Vlutoglou and Kalogerakis (2000).

**Statistical analysis:** The collected data were subjected to analysis of variance (ANOVA) using Minitab software (Minitab, 7.0). Post hock test (Tukey test) used for pairwise comparison NCSS software was used.

## RESULTS

**Incidence of foliar diseases in districts Okara, Pakpattan and Sahiwal:** In district Okara, the late blight incidence was

the maximum (29%) while incidence of early blight was the minimum 4% (Fig.1A). In district Pakpattan, late blight incidence was the maximum (27%) followed by black leg (4%) and early blight 0% (Fig. 1B). In district Sahiwal, the incidence of late blight was the maximum (7%) followed by early blight (6.6%) and black leg 4.5% (Fig. 1C).

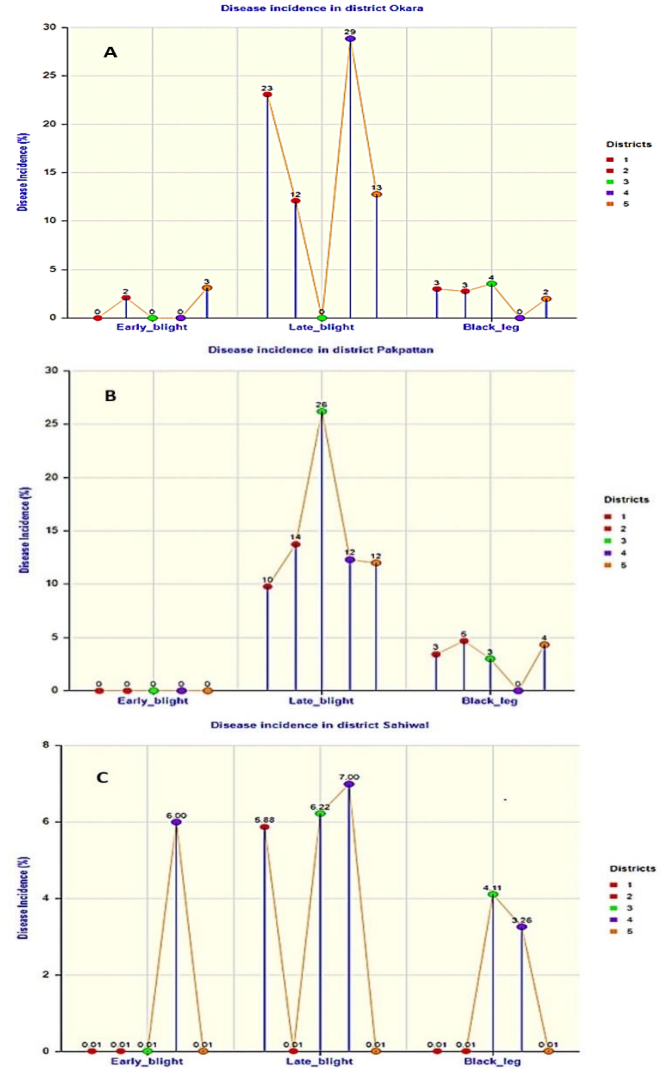


Figure 1. Incidence of late blight, early blight and black leg in central districts of Punjab Province; (A) Okara, (B) Pakpattan, (C) Sahiwal.

Table 1. Potato disease incidence in various districts (Okara, Pakpattan, Sahiwal) in terms of day's interval (germination to maturity).

|         | Okara       |              |           | Pakpattan   |              |           | Sahiwal     |              |           |
|---------|-------------|--------------|-----------|-------------|--------------|-----------|-------------|--------------|-----------|
|         | Late blight | Early blight | Black leg | Late blight | Early blight | Black leg | Late blight | Early blight | Black leg |
| 30 days | 0.01b       | 3.13a        | 0.53b     | 0.01c       | 0            | 0.01c     | 0.01b       | 2.00a        | 0.20b     |
| 60 Days | 20.13a      | 0.01b        | 1.06b     | 13.93b      | 0            | 2.40b     | 4.13ab      | 1.60ab       | 1.86ab    |
| 90 Days | 26.06a      | 0.01b        | 5.20a     | 30.53a      | 0            | 6.86a     | 6.06a       | 0.01b        | 4.00a     |

**Incidence of diseases in district Okara, Pakpattan and Sahiwal after day's intervals:** After 90 days, the maximum incidence of late blight was 26.13% followed by 20.13% after 60 days and 0% after 30 days. The early blight incidence was the maximum (3.13%) after 30 days while no incidence was found after 60 and 90 days. The black leg incidence was the minimum (0.53%) after 30 days and it increased to 1.06% after 60 days and 5.20% after 90 days (Table 1).

No incidence of late blight was found after 30 days but after 90 days, it was the maximum (30.53%). There was no incidence of early blight in district Pakpattan. No black leg incidence was found after 30 days and it was the maximum (6.86%) after 90 days (Table 1).

In district Sahiwal, there was no late blight incidence after 30 days but after 60 days incidence was 4.13%; however, the incidence was the maximum (6.06%) after 90 days. After 60 and 90 days, no incidence of early blight was found while after 30 days the incidence was 2%. The black leg incidence was 0.2% (30 days), 1.86% (60 days) and 4% (90 days) (Table 1).

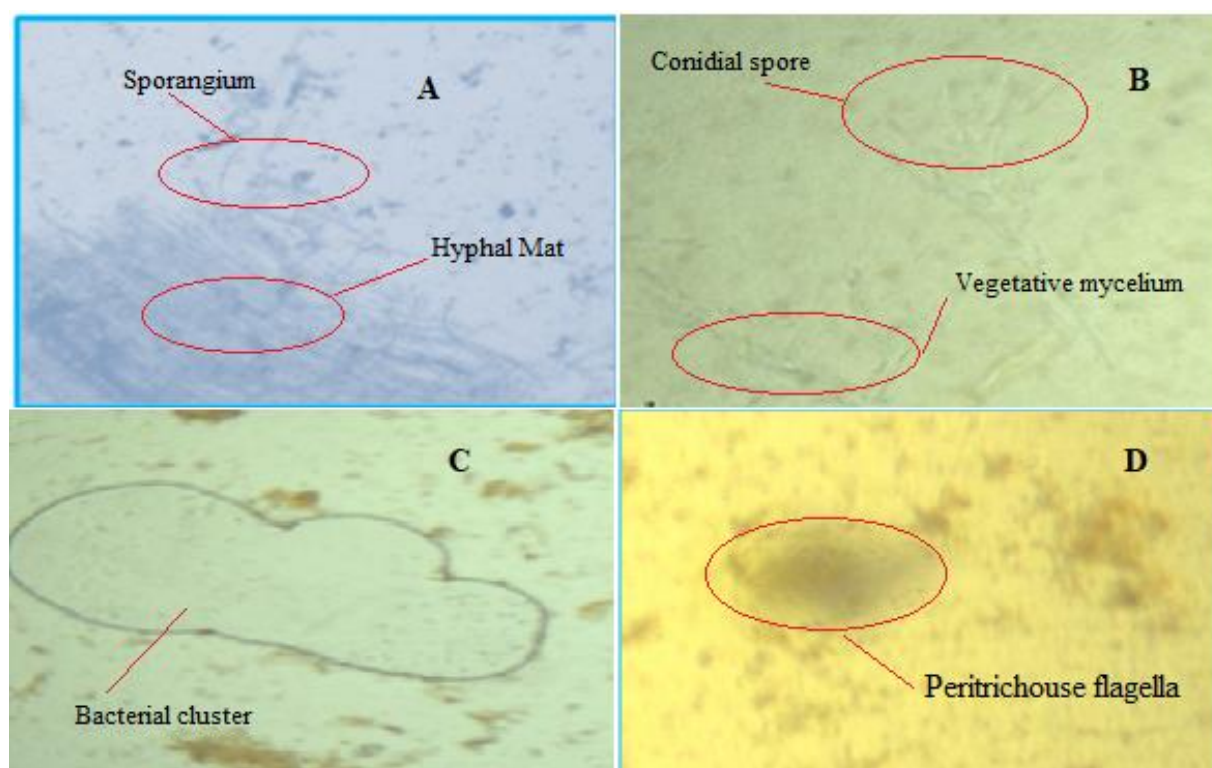
**Comparison of foliar diseases in Okara, Pakpattan and Sahiwal:** Table 2 shows that the incidence of late blight was the maximum (15.40%) in district Okara and the minimum

(3.40%) in district Sahiwal. The early blight incidence was the maximum in Sahiwal and Okara district which was 1.20% and 1.04%, respectively and no incidence of early blight was found in district Pakpattan. In district Pakpattan, the incidence of black leg was the maximum (3.08%) while in district Okara and Sahiwal the incidence was 2.26% and 2.02%, respectively (Table 2).

**Table 2. Comparison of potato disease incidence in Okara, Pakpattan and Sahiwal districts.**

| Districts | Late blight | Early blight | Black leg |
|-----------|-------------|--------------|-----------|
| Okara     | 15.40a      | 1.04ab       | 2.26a     |
| Pakpattan | 14.82a      | 0.01b        | 3.08a     |
| Sahiwal   | 3.40b       | 1.20a        | 2.02a     |

**Microscopic profiling *Phytophthora infestans*, *Alternaria solani* and *Erwinia carotovora*:** The specimen was collected from District Okara pocket 4 (Kharak Singh) of Late blight and visualized in the laboratory under the digital microscope. Figure 2A shows the filamentous Coenocytic hyphal mat of *Phytophthora infestans* causing late blight of potato. Figure 2B indicates the vegetative and reproductive mycelia belonging to *Alternaria solani* causing the early blight



**Figure 2.** (A) A microscopic image of filamentous coenocytic hyphal mat of *Phytophthora infestans* causing late blight of potato (Magnification: 10×), (B) A magnified views of vegetative and reproductive mycelia belonging to *Alternaria solani* causing early blight (Magnification: 40×), (C) A microscopic view of *Erwinia carotovora* causing Black Leg (Soft Rot) of potato (Magnification: 40×), (D) Magnified view of *Erwinia carotovora* causing black leg (soft rot) in potato (Magnification: 40×).

disease. Figure 3C and 3D shows the *Erwinia carotova* causing Black Leg (Soft Rot) of potato.

## DISCUSSION

In Punjab province, potato production is molding from sustenance level to viable endeavor which is one of the main food crops and this area is hub for high yield and quality potato production. In last decade, unfortunately potato crop faced different pathological problems. Among these late blight and black leg are one of the major biotic stresses, yet there are no distributed reports in Punjab with respect to spatial circulation of foliar infections of potato. During survey and meetings with the growers, it was discovered that foliar diseases were predominant in potato growing area of Sahiwal division. The dissemination shifted from locale to region, even from area to area within same district. This is because of unpredictable stream of inadequate impure seed, low slandered quarantine system, mono-cropping, absence of crop rotation and poor harvest farming. Our results associate with the investigation of Hooker (1981) who studied different reasons for high commonness, occurrence and seriousness of black scurf infection included climatic conditions, mono cropping, uncertified potato varieties, absence of crop rotation, dangerous seed stream and absence of isolate systems for the diseases.

Our study provided information on the relative importance and incidence of bacterial and fungal diseases in potato growing areas of Pakistan. Disease incidence information has been collected on foliage part of potato crop and it has not been documented before. The results have thoughtful implication for future research priority, for pesticide regulatory matters and plant health. Black leg, early blight and late blight were chiefly encountered diseases in Sahiwal division while there was divergence in the incidence of every disease from emergence to maturity. In Pakistan, the cultivation of potato has been increased but potato yield is much less than in many other parts of the World (Malik, 1995). In Punjab, mycoplasma pathogens and soil borne diseases of potato cause severe problems in potato cultivated areas. Our study revealed that the incidence of late blight caused by *Phytophthora infestans* was the maximum in all surveyed regions. The favorable temperature enhanced the growth of fungus. The growth of fungus is too fast to kill the entire plant within two weeks. It affected tubers, stems and leaves, and water-soaked spots were observed on potato plants. Contaminated potato (one-fourth to one-half inch below the skin) provides the space for overwintering the pathogen and favorable environmental conditions enhanced the production of sporangiophores bearing many lemon-shaped sporangia. High humidity (90%) is a key factor for the germination of sporangia, and high temperature facilitates the development of mycelia. Moist and cooler climate, 8 to 12 biflagellate motile zoospores are discharged which can enter

specifically into tissue, and furthermore contaminate the potato tubers close to surface of soil (Tantine *et al.*, 1986). Foliage diseases cause the sudden death of plant which lower the yield and contaminated tubers begins spoiling in field and stores (Robertson, 1991). The appropriate management of late blight decreases the foliar and tubers contamination and good culture practices reduce the primary inoculum (Bhattacharya *et al.*, 2002). As indicated by nearby farmers, all the potato seed brought from different districts of the country did not meet the visual standards (interview information from local farmers). Our results and investigation concluded that visual examination system should be executed and implemented to fortify seed regulation.

**Conclusion:** Based on the comprehensive survey of incidence of early blight, late blight and black leg in districts Sahiwal, Pakpattan and Okara, it was concluded that incidence of late blight was maximum while the incidence of early blight was minimum. Among three districts, Sahiwal had the least disease incidence as the farmers are well aware about diseases and adopted good cultural practices, especially use of balanced fertilizers and wise irrigation scheduling.

**Author Contribution Statement:** Nawaz, Hussain, Saleem, Sajid and Sajid planned and wrote the manuscript. Yousafi, Rashid & Mehmood edited the manuscript. All the authors carefully read the paper.

**Funding:** This study was not funded by any national or international agency.

**Conflicts of Interest:** The authors declare no conflict of interest.

**Acknowledgement:** I would like to express my great appreciation to Asim Mehmood for his valuable and constructive suggestion during the planning and development of this research work. His willingness to give his time so much generously has been very much appreciated

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